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Pacific Northwest Environmental Res. Lab.

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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U.S.G.P.O. [illegible]

REPORT

ON

GEIST RESERVOIR

HAMILTON AND MARION COUNTIES

INDIANA

EPA REGION V

WORKING PAPER No. 327

WITH THE COOPERATION OF THE

INDIANA STATE BOARD OF HEALTH

AND THE

INDIANA NATIONAL GUARD

APRIL, 1976

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning {§303(e)}, water quality criteria/standards review {§303(c)}, clean lakes {§314(a,b)}, and water quality monitoring {§106 and §305(b)} activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Indiana State Board of Health for professional involvement, to the Indiana National Guard for conducting the tributary sampling phase of the Survey, and to those Indiana wastewater treatment plant operators who provided effluent samples and flow data.

The staff of the Division of Water Pollution Control, Indiana State Board of Health, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

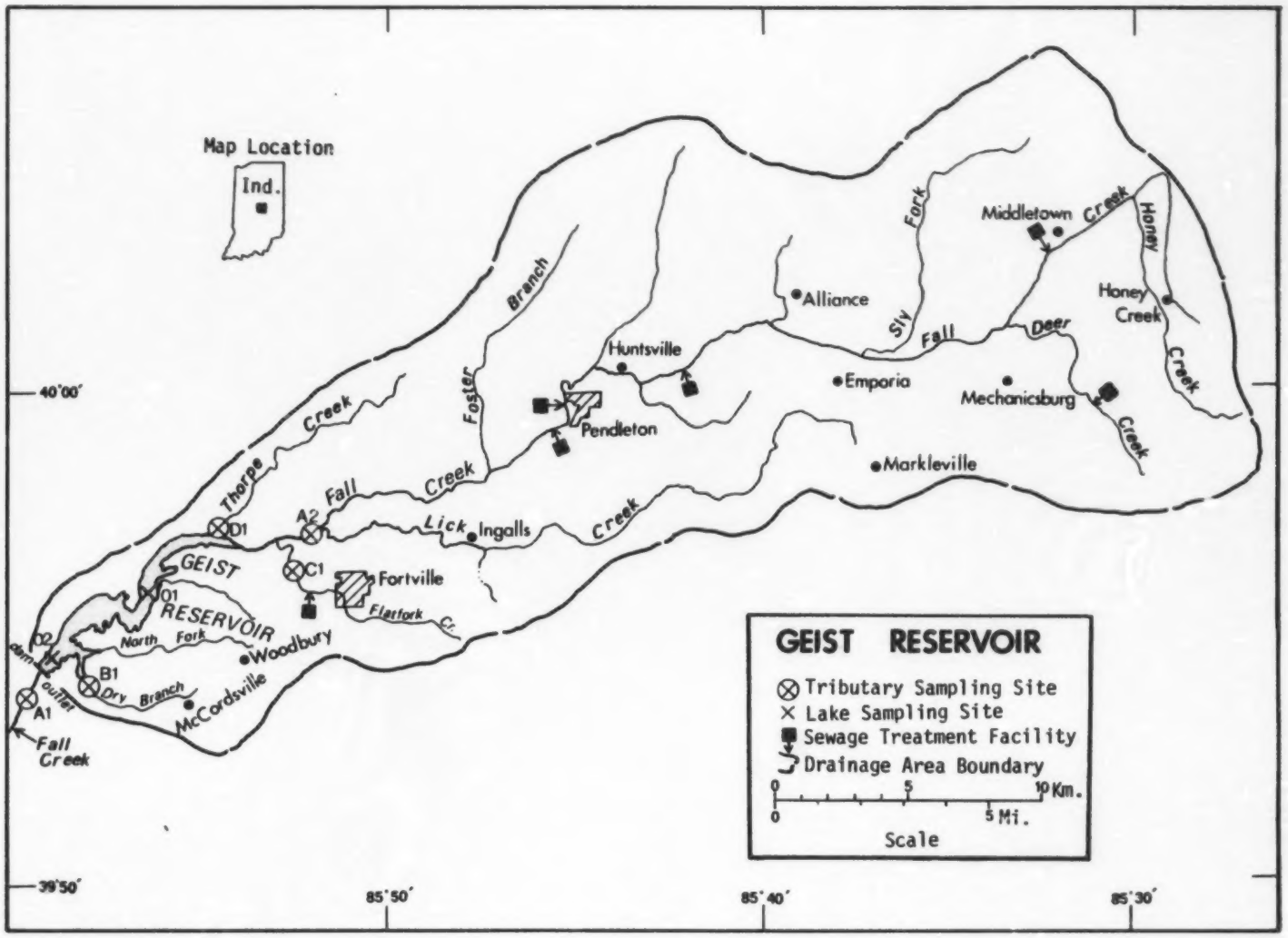
Major General Alfred F. Ahner, Adjutant General of Indiana, and Project Officers Lt. Colonel Charles B. Roberts (Retired) and Colonel Robert L. Sharp, who directed the volunteer efforts of the Indiana National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF INDIANA

LAKE NAME	COUNTY
Bass	Starke
Cataract	Owen, Putnam
Crooked	Steuben
Dallas	LaGrange
Geist	Hamilton, Marion
Hamilton	Steuben
Hovey	Posey
James	Kosciusko
James	Steuben
Long	Steuben
Marsh	Steuben
Mississinewa	Grant, Miami, Wabash
Maxinkuckee	Marshall
Monroe	Brown, Monroe
Morse	Hamilton
Olin	LaGrange
Oliver	LaGrange
Pigeon	Steuben
Sylvan	Noble
Tippecanoe	Kosciusko
Versailles	Ripley
Wawassee	Kosciusko
Webster	Kosciusko
Westler	LaGrange
Whitewater	Union
Winona	Kosciusko
Witmer	LaGrange


Map Location
Ind.
GEIST RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Drainage Area Boundary
0 5 10 Km.
0 5 Mi.
Scale
40°00'
39°50'
85°50'
85°40'
85°30'
Thorpe Creek
Foster Branch
Fall Creek
Lick Creek
Sly Fork
Deer Creek
Honey Creek
Flatfork Cr.
North Fork
Dry Branch
dam
outlet
Fall Creek
Huntsville
Pendleton
Alliance
Middletown
Emporia
Mechanicsburg
Markleville
Ingalls
Fortville
Woodbury
McCordsville
A1
A2
B1
C1
D1
D2

1

GEIST RESERVOIR

STORET NO. 1811

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Geist Reservoir is eutrophic. It ranked 17th when the 27 Indiana lakes sampled in 1973 were compared using a combination of six parameters*. Nineteen of the lakes had less median total phosphorus, nine had less median dissolved phosphorus, 17 had less median inorganic nitrogen, 23 had less mean chlorophyll a, and 22 had greater mean Secchi disc transparency.

Survey limnologists noted emergent and submerged aquatic macrophytes at sampling station 2 and emergent macrophytes along parts of the shoreline.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Geist Reservoir was limited by phosphorus at the time the sample was taken (05/10/73). The reservoir data indicate phosphorus limitation at all sampling times.

C. Nutrient Controllability:

1. Point sources--During the Survey sampling year, five point sources provided samples. In May of 1975, the Indiana Division of Water Pollution Control identified six additional point sources in

* See Appendix A.

the Fall River drainage, determined the phosphorus contribution of four of them, and provided the data for this report (Bon-Homme, 1976). The inclusion of the additional point-source loads permits a more realistic assessment of phosphorus controllability.

It is calculated that the phosphorus contribution of point sources accounted for 32.5% of the total load to Geist Reservoir. The Fortville wastewater treatment plant contributed 10.9%, the Indiana State Reformatory plant contributed 7.6%, and the Middletown plant contributed 6.1% of the total. The remaining six measured point sources collectively contributed 8.0% of the total phosphorus load. The loads from an elementary school and a church camp were not determined but probably were relatively insignificant compared to the measured sources.

The reservoir loading of 2.87 $g/m^2/yr$ is three times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 15). However, the mean hydraulic retention time of the reservoir is a relatively short 58 days, and Vollenweider's model may not apply.

While even complete removal of phosphorus at the listed point sources would still leave a loading of 1.9 $g/m^2/yr$ (ca. twice the eutrophic loading), in view of the questionable applicability of Vollenweider's model and the phosphorus-limited condition of the reservoir, it is likely that a high degree of phosphorus removal at the significant point sources would result in improvement in

the trophic condition of the reservoir.

2. Non-point sources--The phosphorus contributions of non-point sources accounted for 67.2% of the total input to the reservoir. Fall Creek contributed 48.6%, and the remaining three sampled tributaries collectively contributed 12.5% of the total load. The ungaged tributaries were estimated to have contributed 5.5% of the total.

The phosphorus export rate of Dry Branch was a rather high 57 $kg/km^2/yr$. The higher rate may be due in part to the unmeasured McCordsville Elementary School septic-tank load and in part to septic tank drainage from the community of McCordsville.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 7.28 kilometers^2.

2. Mean depth: 3.6 meters.

3. Maximum depth: 6.7 meters.

4. Volume: 26.208 x 10^6 m^3.

5. Mean hydraulic retention time: 58 days.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Fall Creek	440.8	4.21
Dry Branch	19.7	0.18
Flatfork Creek	26.9	0.25
Thorpe Creek	24.6	0.23
Minor tributaries & immediate drainage -	39.9	0.35
Totals	551.9	5.22

2. Outlet -

Fall Creek	559.2**	5.22**

C. Precipitation***:

1. Year of sampling: 122.0 centimeters.

2. Mean annual: 100.8 centimeters.

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† Table of metric conversions--Appendix B.
†† Winters, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake; outflow adjusted to equal sum of inflows.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Geist Reservoir was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at two stations on the reservoir (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 4.3 meters at station 1 and 6.1 meters at station 2.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR GEIST RESERVOIR
STORET CODE 1811

PARAMETER	1ST SAMPLING (5/10/73) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (8/ 2/73) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (10/15/73) 2 SITES RANGE	MEAN	MEDIAN
TEMP (C)	16.2 - 18.2	17.3	17.3	25.3 - 26.3	25.9	26.0	19.6 - 20.8	20.3	20.6
DISS OXY (MG/L)	7.8 - 11.2	9.5	9.6	3.4 - 10.8	7.7	8.8	6.8 - 7.8	7.2	7.0
CNDCTVY (MCROMO)	530. - 590.	560.	560.	442. - 491.	464.	453.	391. - 458.	418.	394.
PH (STAND UNITS)	8.1 - 8.4	8.3	8.3	7.7 - 8.6	8.4	8.5	8.3 - 8.4	8.3	8.3
TOT ALK (MG/L)	196. - 260.	223.	198.	159. - 185.	170.	163.	151. - 190.	166.	155.
TOT P (MG/L)	0.050 - 0.089	0.063	0.058	0.043 - 0.179	0.097	0.059	0.074 - 0.137	0.098	0.092
ORTHO P (MG/L)	0.004 - 0.013	0.007	0.006	0.009 - 0.027	0.014	0.010	0.006 - 0.016	0.011	0.009
NO2+NO3 (MG/L)	2.210 - 3.020	2.641	2.890	0.330 - 0.990	0.740	0.990	0.060 - 0.120	0.079	0.080
AMMONIA (MG/L)	0.060 - 0.150	0.079	0.060	0.030 - 0.330	0.128	0.090	0.070 - 0.120	0.104	0.110
KJEL N (MG/L)	0.600 - 0.800	0.700	0.700	1.100 - 2.200	1.520	1.200	0.900 - 1.200	1.057	1.000
INORG N (MG/L)	2.280 - 3.140	2.720	2.950	0.360 - 1.320	0.868	1.080	0.150 - 0.210	0.183	0.180
TOTAL N (MG/L)	2.920 - 3.690	3.341	3.590	2.090 - 2.530	2.260	2.190	0.970 - 1.320	1.136	1.080
CHLRPYL A (UG/L)	34.9 - 54.2	44.5	44.5	17.4 - 94.1	55.7	55.7	4.7 - 70.4	37.5	37.5
SECCHI (METERS)	0.5 - 0.9	0.7	0.7	0.4 - 1.0	0.7	0.7	0.6 - 0.8	0.7	0.7

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
05/10/73	1. *Melosira sp.*	1,803
	2. *Cyclotella sp.*	1,277
	3. *Dactylococcopsis sp.*	992
	4. *Asterionella sp.*	947
	5. *Stephanodiscus sp.*	841
	Other genera	5,438
	Total	11,298
08/02/73	1. Centric diatoms	11,605
	2. Flagellates	9,579
	3. *Melosira sp.*	6,868
	4. *Euglena sp.*	468
	5. *Synedra sp.*	426
	Other genera	2,884
	Total	31,830
10/15/73	1. Centric diatoms	14,908
	2. *Melosira sp.*	4,820
	3. Flagellates	3,479
	4. *Oscillatoria sp.*	2,335
	5. *Merismopedia sp.*	1,888
	Other genera	8,251
	Total	35,681

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (μg/l)
05/10/73	1	54.2
	2	34.9
08/02/73	1	94.1
	2	17.4
10/15/73	1	70.4
	2	4.7

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.015	2.380	3.4
0.050 P	0.065	2.380	20.6
0.050 P + 1.0 N	0.065	3.380	21.8
1.0 N	0.015	3.380	2.9

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Geist Reservoir was moderately high at the time the sample was taken (05/10/73). Also, a six-fold increase in yield with the addition of only phosphorus indicates the reservoir was phosphorus limited at that time. Note that the addition of only nitrogen resulted in a yield not significantly different from that of the control.

The reservoir data also indicate phosphorus limitation; i.e., the mean inorganic nitrogen to orthophosphorus ratios were 17 to 1 or greater at all sampling times, and phosphorus limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Indiana National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of February and March when two samples were collected. Sampling was begun in June, 1973, and was completed in May, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Indiana District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

Except for Flatfork Creek, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. The phosphorus load measured in Flatfork Creek at station C-1 was less than the Fortville wastewater treatment plant load, and the non-point nutrient loads of this stream were estimated (see below). The Fall Creek nutrient loads shown are those measured minus the point-source loads.

Nutrient loads for Flatfork Creek and unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the nutrient loads at station D-1, in $kg/km^2/year$, and multiplying by the Flatfork Creek and ZZ areas in km^2.

* See Working Paper No. 175.

The operators of the Indiana State Reformatory, Pendleton, Middletown, Fortville, and Shenandoah High School wastewater treatment plants provided monthly effluent samples and corresponding flow data.

The estimated phosphorus load from septic tanks was reduced by 50% to adjust for a phosphate detergent ban which has been in effect in Indiana since January, 1972.

A. Waste Sources:

1. Known domestic† -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Indiana State Reformatory	2,300	tr. filter	1,403.3	Fall Creek
Pendleton	2,496	act. sludge	881.4	Fall Creek
Middletown	2,300	tr. filter	1,539.5	Fall Creek
Fortville	2,480	tr. filter	1,860.8	Flatfork Creek
Ingalls	888	septic tanks	336.1	Lick Creek
Regency MHP	?	ext. aer. + pond	11.4	Fall Creek
Shenandoah High Sch.*	700	act. sludge	11.4	Deer Creek
McCordsville Elem. Sch.	?	septic tank	?	Stansbury Ditch/ Dry Branch
U. Pentecostal Camp	?	ext. aer.	113.6**	Lick Creek

† Treatment plant questionnaires; Anonymous, 1971.
* School operates 9 mo./year; pop. equivalent=125.
** Design flow.

2. Known industrial* -

Name	Treatment	Mean Flow (m^3/d)	Receiving Water
E. I. DuPont Nemours Co.	neutralization	26.5	Stottlemeyer Ditch/Flat-fork Creek
Brookside Corp.			
#1	metal recovery	75.7	Dry Branch Creek
#2	lagoon	128.7	Dry Branch Creek
Forthrite Div., Richardson Co.			
#1	(washwater)	50.7	Stansbury Ditch/ Dry Branch
#2	septic tank	no discharge	Stansbury Ditch/ Dry Branch

* BonHomme, 1976.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Fall Creek	10,175	48.6
Dry Branch	1,130	5.4
Flatfork Creek	780	3.7
Thorpe Creek	710	3.4
b. Minor tributaries & immediate drainage (non-point load) -	1,155	5.5
c. Known domestic STP's -		
Indiana State Reformatory	1,600	7.6
Pendleton	930	4.4
Middletown	1,270	6.1
Fortville	2,275	10.9
Regency MHP	110	0.5
Shenandoah High School	10	<0.1
McCordsville Elem. Sch.	?	-
Pentecostal Camp	?	-
d. Septic tanks* -	55	0.3
e. Known industrial -		
E. I. DuPont Nemours	60	0.3
Brookside Corp.	540	2.6
Forthrite Div.	20	<0.1
f. Direct precipitation** -	125	0.6
Total	20,945	100.0

2. Outputs -

Lake outlet - Fall Creek 12,625

3. Net annual P accumulation - 8,320 kg.

* Estimate based on 1970 Census of Ingalls and 38 lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Fall Creek	444,795	66.8
Dry Branch	36,200	5.4
Flatfork Creek	45,435	6.8
Thorpe Creek	41,545	6.2
b. Minor tributaries & immediate drainage (non-point load) -	67,390	10.1
c. Known domestic STP's -		
Indiana State Reformatory	2,850	0.4
Pendleton	3,750	0.6
Middletown	5,155	0.8
Fortville	6,390	1.0
Regency MHP	?	-
Shenandoah High School	20	<0.1
McCordsville Elem. Sch.	?	-
Pentecostal Camp	?	-
d. Septic tanks* -	4,190	0.6
e. Known industrial -		
E. I. DuPont Nemours	?	-
Brookside Corp.	?	-
Forthrite Div.	?	-
f. Direct precipitation** -	7,860	1.2
Total	665,580	100.0

2. Outputs -

Lake outlet - Fall Creek 681,175

3. Net annual N loss - 15,595 kg.

* Estimate based on 1970 Census of Ingalls and 38 lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Fall Creek	23	1,009
Dry Branch	57	1,838
Thorpe Creek	29	1,689

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	2.88	1.14	91.4	loss*

Vollenweider phosphorus loadings (g/m^2/yr) based on mean depth and mean hydraulic retention time of Geist Reservoir:

"Dangerous" (eutrophic loading)	0.92
"Permissible" (oligotrophic loading)	0.46

* There was an apparent nitrogen loss during the sampling year. This may have been due to nitrogen fixation in the reservoir, solubilization of previously sedimented nitrogen, recharge with nitrogen-rich ground water, or unknown point sources discharging directly to the reservoir. Whatever the cause, a similar loss has occurred at Shagawa Lake, Minnesota, which has been intensively studied by EPA's former National Eutrophication and Lake Restoration Branch (Malueg et al., 1975).

V. LITERATURE REVIEWED

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VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
1805	CATARACT LAKE	0.058	1.660	466.667	10.744	15.000	0.013
1811	GEIST RESERVOIR	0.074	1.080	472.500	45.950	11.600	0.009
1817	JAMES LAKE	0.024	1.030	434.000	11.533	15.000	0.008
1827	MISSISSINEWA RESERVOIR	0.107	2.400	473.444	15.778	15.000	0.029
1828	MONROE RESERVOIR	0.025	0.325	438.623	6.947	15.000	0.007
1829	MORSE RESERVOIR	0.084	3.325	473.222	56.167	15.000	0.009
1836	WAWASEE LAKE	0.012	0.210	364.500	5.000	14.600	0.003
1837	WEBSTER LAKE	0.025	0.790	431.000	11.500	15.000	0.005
1839	WHITEWATER LAKE	0.084	1.620	470.167	33.083	15.000	0.012
1840	WINONA LAKE	0.035	1.250	444.667	11.211	15.000	0.011
1841	WESTLER LAKE	0.035	0.860	427.125	10.712	15.000	0.013
1842	WITMER LAKE	0.035	0.900	440.333	11.917	15.000	0.011
1843	LAKE MAXINKUCKEE	0.020	0.220	400.400	5.483	15.000	0.003
1844	TIPPECANOE LAKE	0.019	0.195	391.500	6.050	15.000	0.005
1845	DALLAS LAKE	0.029	0.830	413.333	10.067	15.000	0.014
1846	OLIN LAKE	0.012	1.460	403.333	4.867	14.900	0.003
1847	OLIVER LAKE	0.009	0.920	392.000	3.767	14.800	0.004
1848	SYLVAN LAKE	0.170	0.130	469.833	47.480	14.800	0.017
1849	HOVEY LAKE	0.062	1.050	489.333	84.267	7.600	0.024
1850	VERSAILLES LAKE	0.139	1.090	482.000	25.078	14.500	0.019
1851	BASS LAKE	0.040	0.250	471.375	29.367	7.000	0.012
.852	CROOKED LAKE	0.019	0.120	410.111	5.578	15.000	0.005
1853	LAKE JAMES	0.016	0.190	352.444	4.856	15.000	0.005
1854	LONG LAKE	0.204	1.920	442.667	16.100	15.000	0.150
1855	PIGEON LAKE	0.058	1.945	442.667	11.900	15.000	0.015
1856	MARSH LAKE	0.093	0.270	451.333	34.467	15.000	0.055
1857	HAMILTON LAKE	0.033	0.720	413.167	17.450	15.000	0.018

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
1805	CATARACT LAKE	37 (9)	15 (4)	31 (8)	62 (16)	35 (0)	37 (9)	217
1811	GEIST RESERVOIR	27 (7)	35 (9)	15 (4)	12 (3)	92 (24)	62 (16)	243
1817	JAMES LAKE	73 (19)	42 (11)	58 (15)	50 (13)	35 (0)	65 (17)	323
1827	MISSISSINEWA RESERVOIR	12 (3)	4 (1)	8 (2)	38 (10)	35 (0)	8 (2)	105
1828	MONROE RESERVOIR	67 (17)	69 (18)	54 (14)	73 (19)	35 (0)	69 (18)	367
1829	MORSE RESERVOIR	23 (6)	0 (0)	12 (3)	4 (1)	35 (0)	58 (15)	132
1836	WAWASEE LAKE	94 (24)	85 (22)	96 (25)	88 (23)	85 (22)	98 (25)	546
1837	WEBSTER LAKE	67 (17)	62 (16)	62 (16)	54 (14)	35 (0)	81 (21)	361
1839	WHITEWATER LAKE	19 (5)	19 (5)	23 (6)	19 (5)	35 (0)	42 (11)	157
1840	WINONA LAKE	50 (12)	27 (7)	38 (10)	58 (15)	35 (0)	52 (13)	260
1841	WESTLER LAKE	50 (12)	54 (14)	65 (17)	65 (17)	35 (0)	37 (9)	306
1842	WITMER LAKE	50 (12)	50 (13)	50 (13)	42 (11)	35 (0)	52 (13)	279
1843	LAKE MAXINKUCKEE	77 (20)	81 (21)	85 (22)	85 (22)	35 (0)	98 (25)	461
1844	TIPPECANOE LAKE	85 (22)	88 (23)	92 (24)	77 (20)	35 (0)	85 (22)	462
1845	DALLAS LAKE	62 (16)	58 (15)	69 (18)	69 (18)	35 (0)	31 (8)	324
1846	OLIN LAKE	94 (24)	23 (6)	81 (21)	92 (24)	73 (19)	92 (24)	455
1847	OLIVER LAKE	100 (26)	46 (12)	88 (23)	100 (26)	79 (20)	88 (23)	501
1848	SYLVAN LAKE	4 (1)	96 (25)	27 (7)	8 (2)	79 (20)	23 (6)	237
1849	HOVEY LAKE	31 (8)	38 (10)	0 (0)	0 (0)	96 (25)	12 (3)	177
1850	VERSAILLES LAKE	8 (2)	31 (8)	4 (1)	27 (7)	88 (23)	15 (4)	173
1851	BASS LAKE	42 (11)	77 (20)	19 (5)	23 (6)	100 (26)	46 (12)	307
1852	CROOKED LAKE	81 (21)	100 (26)	77 (20)	81 (21)	35 (0)	75 (19)	449
1853	LAKE JAMES	88 (23)	92 (24)	100 (26)	96 (25)	35 (0)	75 (19)	486
1854	LONG LAKE	0 (0)	12 (3)	44 (11)	35 (9)	35 (0)	0 (0)	126
1855	PIGEON LAKE	37 (9)	8 (2)	44 (11)	46 (12)	35 (0)	27 (7)	197
1856	MANSH LAKE	15 (4)	73 (19)	35 (9)	15 (4)	35 (0)	4 (1)	177
1857	HAMILTON LAKE	50 (15)	65 (17)	73 (19)	31 (8)	35 (0)	19 (5)	281

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	1836	WAWASEE LAKE	546
2	1847	OLIVER LAKE	501
3	1853	LAKE JAMES	486
4	1844	TIPPECANOE LAKE	462
5	1843	LAKE MAXINKUCKEE	461
6	1846	OLIN LAKE	455
7	1852	CROOKED LAKE	449
8	1828	MONROE RESERVOIR	367
9	1837	WEBSTER LAKE	361
10	1845	DALLAS LAKE	324
11	1817	JAMES LAKE	323
12	1851	BASS LAKE	307
13	1841	WESTLER LAKE	306
14	1857	HAMILTON LAKE	281
15	1842	WITMER LAKE	279
16	1840	WINONA LAKE	260
17	1811	GEIST RESERVOIR	243
18	1848	SYLVAN LAKE	237
19	1805	CATARACT LAKE	217
20	1855	PIGEON LAKE	197
21	1856	MARSH LAKE	177
22	1849	MOVEY LAKE	177
23	1850	VERSAILLES LAKE	173
24	1839	WHITEWATER LAKE	157
25	1829	MORSE RESERVOIR	132
26	1854	LONG LAKE	126
27	1827	MISSISSINEWA RESERVOIR	105

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR INDIANA 03/29/76

LAKE CODE 1811 GEIST RESERVOIR

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 557.1

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1811A1	559.2	7.39	8.16	11.10	10.62	7.02	5.18	3.26	1.47	1.25	1.39	2.75	4.81	5.35
1811A2	440.8	5.78	6.43	8.78	8.38	5.52	4.08	2.55	1.13	0.96	1.08	2.18	3.79	4.21
1811B1	19.7	0.227	0.280	0.425	0.368	0.241	0.184	0.110	0.034	0.034	0.037	0.096	0.181	0.184
1811C1	26.9	0.311	0.396	0.566	0.510	0.340	0.252	0.150	0.048	0.048	0.051	0.130	0.246	0.253
1811D1	24.6	0.283	0.340	0.510	0.481	0.311	0.232	0.139	0.045	0.042	0.045	0.119	0.227	0.230
1811ZZ	37.8	0.453	0.538	0.765	0.708	0.453	0.368	0.212	0.071	0.068	0.074	0.184	0.340	0.351

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 557.1 TOTAL FLOW IN = 62.93
SUM OF SUB-DRAINAGE AREAS = 549.9 TOTAL FLOW OUT = 64.39

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1811A1	6	73	9.628	9	11.044				
	7	73	3.115	8	3.115				
	8	73	2.973	12	7.342				
	9	73	1.699	9	1.614				
	10	73	1.841	16	1.869				
	11	73	4.248	10	1.841				
	12	73	11.327	9	3.681				
	1	74	19.255	12	4.814				
	2	74	9.911	9	9.345	24	11.327		
	3	74	11.327	10	8.495	17	10.336		
	4	74	12.176	7	13.826				
	5	74	7.646	12	10.477				
1811A2	6	73	6.881	9	7.872				
	7	73	2.461	8	2.209				
	8	73	2.353	12	5.125				
	9	73	1.201	9	1.133				
	10	73	1.280	16	1.303				
	11	73	2.973	10	1.274				
	12	73	7.929	9	2.605				
	1	74	13.451	12	3.398				
	2	74	7.051	9	6.598	24	8.099		
	3	74	8.042	10	5.947	17	7.362		
	4	74	8.552	7	9.146				
	5	74	5.409	12	7.391				

TRIBUTARY FLOW INFORMATION FOR INDIANA 03/29/76

LAKE CODE 1811 GEIST RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1811B1	6	73	0.389	9	0.340				
	7	73	0.051	8	0.040				
	8	73	0.045	12	0.224				
	9	73	0.011	9	0.008				
	10	73	0.011	16	0.011				
	11	73	0.074	10	0.011				
	12	73	0.340	9	0.054				
	1	74	0.595	12	0.099				
	2	74	0.311	9	0.283	24	0.368		
	3	74	0.368	10	0.266	17	0.340		
	4	74	0.368	7	0.396				
	5	74	0.241	12	0.340				
1811C1	6	73	0.425	9	0.481				
	7	73	0.147	10	0.119				
	8	73	0.144	12	0.311				
	9	73	0.074	9	0.068				
	10	73	0.079	16	0.082				
	11	73	0.178	10	0.074				
	12	73	0.481	9	0.159				
	1	74	0.821	12	0.207				
	2	74	0.425	9	0.396	24	0.481		
	3	74	0.481	10	0.368	17	0.453		
	4	74	0.538	7	0.566				
	5	74	0.340	12	0.453				
1811D1	6	73	0.368	9	0.425				
	7	73	0.076	8	0.062				
	8	73	0.071	12	0.278				
	9	73	0.020	9	0.017				
	10	73	0.023	13	0.023				
	11	73	0.108	10	0.023				
	12	73	0.425	9	0.085				
	1	74	0.736	12	0.136				
	2	74	0.396	9	0.368	24	0.453		
	3	74	0.453	10	0.311	17	0.396		
	4	74	0.481	7	0.510				
	5	74	0.311	12	0.396				
1811ZZ	6	73	0.595	9	0.680				
	7	73	0.212	8	0.190	10	0.164		
	8	73	0.201	12	0.453				
	9	73	0.102	9	0.096				
	10	73	0.110	13	0.110	16	0.113		
	11	73	0.255	10	0.110				
	12	73	0.680	9	0.224				
	1	74	1.161	12	0.283				
	2	74	0.595	9	0.566	24	0.708		
	3	74	0.680	10	0.510	17	0.623		
	4	74	0.736	7	0.793				
	5	74	0.453	12	0.623				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/03/30

181101
39 55 59.0 085 56 17.0 3
GEIST RESERVOIR
18057 INDIANA
051992

11EPALES 2111202
0018 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/05/10	11 10	0000	18.2		21	590	8.20	260	0.060	0.700	2.220	0.013
	11 10	0006	18.1	11.2		580	8.30	260	0.060	0.700	2.240	0.008
	11 10	0014	17.5	9.1		580	8.10	250	0.080	0.800	2.210	0.009
73/08/02	15 05	0000	26.2		14	491	8.60	185	0.030	2.200	0.330	0.027
	15 05	0005	25.8	10.8		489	8.50	182	0.080	2.000	0.400	0.015
73/10/15	10 20	0000	19.9		24	444	8.40	178	0.120	1.200	0.080	0.015
	10 20	0005	19.6	7.8		458	8.40	190	0.090	1.200	0.120	0.016
	10 20	0008	19.6	7.6		456	8.30	184	0.070	1.000	0.080	0.015

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/05/10	11 10	0000	0.089	54.2
	11 10	0006	0.050	
	11 10	0014	0.067	
73/08/02	15 05	0000	0.179	94.1
	15 05	0005	0.157	
73/10/15	10 20	0000	0.095	70.4
	10 20	0005	0.137	
	10 20	0008	0.133	

STORET RETRIEVAL DATE 76/03/30

181102
39 54 38.0 085 58 56.0 3
GEIST RESERVOIR
18097 INDIANA
051992

11EPALES 2111202
0023 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/05/10	11 45	0000	17.3		34	530	8.40	198	0.060	0.700	2.890	0.006
	11 45	0004	17.0	9.9		540	8.40	198	0.060	0.600	3.020	0.005
	11 45	0015	16.8	9.6		540	8.30	196	0.080	0.700	2.920	0.004
	11 45	0020	16.2	7.8		560	8.30	197	0.150	0.700	2.990	0.005
73/08/02	14 55	0000	26.3		40	444	8.50	159	0.110	1.200	0.990	0.009
	14 55	0005	26.0	8.8		442	8.50	160	0.090	1.100	0.990	0.009
	14 55	0017	25.3	3.4		453	7.70	163	0.330	1.100	0.990	0.010
73/10/15	10 40	0000	20.8		32	391	8.40	151	0.120	1.000	0.080	0.009
	10 40	0005	20.7	6.8		393	8.30	155	0.110	0.900	0.070	0.009
	10 40	0010	20.7	6.8		394	8.30	152	0.100	1.000	0.060	0.006
	10 40	0018	20.6	7.0		392	8.30	152	0.120	1.100	0.060	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/05/10	11 45	0000	0.070	34.9
	11 45	0004	0.057	
	11 45	0015	0.051	
	11 45	0020	0.058	
73/08/02	14 55	0000	0.059	17.4
	14 55	0005	0.049	
	14 55	0017	0.043	
73/10/15	10 40	0000	0.074	4.7
	10 40	0005	0.077	
	10 40	0010	0.081	
	10 40	0018	0.092	

APPENDIX E

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/03/30

1M11A1
39 53 55.0 085 59 29.0 4
FALL CREEK
18 7.5 MCCORDSVILLE
O/GEIST RES 051992
79TH ST BRDG BELO GEIST RES DAM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/06/09	10 40		9.500	1.500	0.050	0.054	0.115
73/07/08	11 00		2.040	0.350	0.024	0.031	0.045
73/08/12	10 20		1.380	3.400	0.060		
73/09/09	14 25		0.530	0.320	0.015	0.032	0.055
73/10/16	18 45		1.060	0.400	0.023	0.057	0.085
73/11/10	11 30		1.040	0.250	0.009	0.017	0.040
73/12/09	10 45		3.500	1.000	0.032	0.028	0.028
74/01/12	10 20		3.080	0.400	0.056	0.044	0.055
74/02/09	14 40		3.600	0.200	0.030	0.020	0.030
74/02/24	13 00		4.200	1.700	0.090	0.100	0.150
74/03/10	10 00		3.780	0.400	0.030	0.020	0.055
74/03/17	10 30		2.900	0.600	0.025	0.020	0.070
74/04/07	15 10		4.300	0.900	0.020	0.035	0.070
74/05/12	14 10		3.250	1.100	0.125	0.050	0.170

STORET RETRIEVAL DATE 76/03/30

1811A2
39 57 16.0 085 52 01.0 4
FALL CREEK
18 7.5 INGALLS
I/GEIST RES 051992
ST HWY 238 BRDG 2 MI NNW OF FORTVILLE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/06/09	12	35	5.400	1.100	0.069	0.052	0.140
73/07/08	11	30	2.400	0.380	0.016	0.075	0.115
73/08/12	09	10	1.340	1.890	0.061	0.110	
73/09/09	13	45	1.700	0.840	0.078	0.096	0.150
73/10/16	18	05	1.460	0.550	0.039	0.115	0.170
73/11/10	10	38	1.560	0.200	0.023	0.084	0.102
73/12/09	09	45	2.520	0.400	0.048	0.048	0.065
74/01/12	12	25	3.500	0.300	0.012	0.020	0.030
74/02/09	13	45	3.400	0.700	0.055	0.030	0.055
74/02/24	14	10	2.100	0.500	0.055	0.155	0.175
74/03/10	10	00	3.300	0.600	0.025	0.035	0.105
74/03/17	09	30	3.000	0.600	0.030	0.035	0.090
74/04/07	14	20	3.600	0.800	0.030	0.035	0.065
74/05/12	13	20	2.400	1.000	0.047	0.022	0.120

STORET RETRIEVAL DATE 76/03/30

181181
39 54 05.0 085 57 50.0 4
DRY BRANCH
18 7.5 MCCORDSVILLE
T/GEIST RES 051992
FOX RD BRDG 1.5 MI N OF OCKLANDON
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/06/09	11 45		10.600	6.400	0.480	0.079	0.125
73/07/08	10 20		4.600	0.790	0.042		
73/08/12	10 07		1.000	1.540	0.150	0.680	0.880
73/09/09	14 10		0.051	1.760	0.165	0.236	0.500
73/10/16	18 30		0.790	0.750	0.020	0.510	0.620
73/11/10	11 10		1.510	0.650	0.039	0.580	0.605
73/12/09	10 35		4.600	0.500	0.096	0.080	0.105
74/01/12	11 15		5.600	0.400	0.008	0.020	0.030
74/02/09	14 30		5.000	0.700	0.030	0.050	0.075
74/02/24	13 30		4.100	0.800	0.090	0.090	0.165
74/03/10	10 30		4.900	0.500	0.025	0.085	0.130
74/03/17	09 10		4.700	0.600	0.025	0.085	0.128
74/04/07	14 50		5.460	0.400	0.005K	0.025	0.030
74/05/12	13 45		7.500	2.500	0.560	0.230	0.350

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/30

1811C1
39 56 30.0 085 52 30.0 4
FLATFORK CREEK
18 7.5 MCCORDSVILLE
T/GEIST RES 051992
CONNECTICUT AVE BRDG 1.5 MI W OF FORTVIL
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/10	16 00		1.980	0.480	0.031	0.023	0.055
73/08/12	09 15		1.320	1.260	0.052	0.073	
73/09/09	13 50		1.500	0.460	0.044	0.046	0.070
73/10/16	18 10		1.200	0.400	0.006	0.039	0.075
73/11/10	10 45		1.440	0.150	0.009	0.016	0.020
73/12/09	09 55		2.400	0.500	0.026	0.024	0.030
74/01/12	12 00		4.100	0.500	0.068	0.068	0.095
74/02/09	13 50		3.200	0.300	0.005	0.015	0.025
74/02/24	13 30		4.100	1.000	0.110	0.090	0.140
74/03/10	11 00		3.000	0.400	0.010	0.020	0.050
74/03/17	12 00		2.900	0.500	0.010	0.050	0.055
74/04/07	14 25		3.200	0.500	0.010	0.017	0.040
74/05/12	13 25		3.600	0.900	0.060	0.025	0.105

STORET RETRIEVAL DATE 76/03/30

181101
39 57 17.0 085 54 31.0 4
THORPE CREEK
18 7.5 MCCONOSVILLE
T/GEIST RES 051992
E 113TH ST BRDG 3.5 MI WNW OF FORTVILLE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/06/09	12 05		9.900	1.320	0.082	0.065	0.105
73/07/08	11 00		4.300	0.540	0.066	0.042	0.065
73/08/12	09 05		2.200	2.310	0.110	0.220	0.560
73/09/09	13 40		0.770	1.000	0.058	0.037	0.125
73/10/13	07 50		0.610	0.780	0.044	0.063	0.105
73/11/10	10 30		1.430	0.300	0.007	0.014	0.025
73/12/09	09 30		5.040	0.300	0.008	0.020	0.025
74/01/12	10 25		2.900	0.300	0.016	0.020	0.020
74/02/09	13 30		5.700	0.200	0.012	0.015	0.020
74/02/24	13 40		4.100	1.000	0.130	0.090	0.140
74/03/10	10 45		6.300	0.400	0.010	0.020	0.035
74/03/17	11 30		6.100	0.400	0.010	0.020	0.030
74/04/07	14 10		6.800	0.600	0.005	0.020	0.035
74/05/12	13 15		5.200	1.200	0.030	0.010	0.060

STORET RETRIEVAL DATE 76/03/30

1811XA PD1811XA P000125
40 00 30.0 085 30 30.0 4
SHENANDOAH HI SCHOOL
18 HENRY CO HWY MAP
T/GEIST RESERVOIR 051991
SUGAR CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/06/29	08	35	0.210	2.300	0.084	5.430	5.800		
73/07/30	08	35	0.160	1.900	0.042	3.700	4.100		
73/08/29	12	30		1.900	0.132	2.980	3.500		
73/09/24	11	30	0.150	1.000	0.450	3.990	4.000	0.003	0.003
73/10/31	09	15	0.530	0.600	0.010K	1.380	1.550	0.003	0.003
73/11/28	13	00	4.400	0.930	0.068	2.100	2.400	0.003	0.003
73/12/17	11	45	3.300	0.700	0.063	2.900	3.400	0.003	0.003
74/01/16	13	45	9.950	0.500K	0.040	2.670	2.900	0.003	0.003
74/02/20	10	30	4.700	1.000K	0.050K	2.500	2.700	0.003	0.003
74/03/25	15	00	4.300	1.000K	0.050K	0.840	1.100	0.003	0.003
74/04/23	07	00	2.160	2.400	0.063	1.150	1.300	0.003	0.003
74/05/22	12	30	3.700	1.000K	0.050K	0.470	0.570	0.003	0.003
74/06/14	14	00	4.200	1.000K	0.050K	0.434	0.470	0.003	0.003

K VALUE KNOWN TO BE
LESS THAN INDICATED

-58-

STORET RETRIEVAL DATE 76/03/30

1811CA TF1811CA P002480
39 26 05.0 085 51 50.0 4
FORTVILLE
18 7.5 INGALLS
T/GEIST RESERVOIR 051891
FLATFORK CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/06/29	10	30	2.730	5.510	0.120	1.000	1.650	0.659	0.500
73/07/30	09	30	1.980	6.200	0.050	1.050	1.750	0.397	0.300
73/09/07	08	00	0.510	10.300	0.410	2.020	2.600	0.379	0.420
73/09/28	08	30	1.380	15.000	1.440	2.800	3.700	0.361	0.400
73/10/29	10	30	0.315	16.500	3.300	2.920	4.300	0.300	0.300
73/11/30	10	00	2.900	4.700	0.057	0.590	0.860	0.700	0.400
73/12/24	08	00	1.000	7.000	0.048	1.200	1.650	0.500	0.500
74/03/13	14	00	0.160	6.800	0.050K	0.120	2.400	0.719	0.700
74/04/15	09	00	2.160	12.000	4.100	5.800	15.700	0.670	0.690
74/06/26	09	00	3.780	2.700	0.085	0.450	0.560	0.711	0.689
74/07/12	08	30	1.080	3.500	0.740	1.100	1.350	0.500	0.600
74/08/08	08	00	0.800	12.000	1.250	1.350	2.000	0.300	0.400

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/30

1811AC TF1811AC P002300
40 03 10.0 085 32 15.0 4
MIDDLETON
18 7.5 MIDDLETON
T/GEIST RESERVOIR 051991
FALL CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/06/12 11 00 CP(T)- 73/06/12 20 00			2.000	4.230	0.020	1.170	1.500	0.556	0.519
73/07/10 11 00 CP(T)- 73/07/10 16 00			1.600	6.100	0.059	1.000	2.500	0.463	0.519
73/08/15 16 15			2.000	7.100	0.160	0.700		0.722	0.450
73/09/12 07 00 CP(T)- 73/09/12 15 00			2.600	8.300	0.107	2.300	3.000	0.200	0.347
73/10/09 07 00 CP(T)- 73/10/09 15 30			3.200	8.000	0.031	2.500	3.500	0.316	0.347
73/11/12 07 00 CP(T)- 73/11/12 15 00			3.000	8.000	1.090	2.310	2.000	0.303	0.307
73/12/14 15 20			1.920	12.000	0.110	2.300	3.100	0.259	0.204
74/01/17 07 00 CP(T)- 74/01/17 15 00			1.760	4.600	0.100	1.400	5.750	0.320	0.261
74/02/12 07 00 CP(T)- 74/02/12 15 00			2.000	5.500	0.099	1.160	1.750	0.306	0.330
74/03/12 07 00 CP(T)- 74/03/12 15 00			2.640	5.300	0.110	1.150	1.900	0.314	0.341
74/04/10 07 00 CP(T)- 74/04/10 15 00			3.600	4.400	0.050K	0.000	1.250	0.759	0.384
74/05/21 20 00			2.640	7.200	0.050K	0.010	1.700	0.566	0.635
74/06/13 22 25			3.600	6.200	0.045	0.500	1.000	0.733	0.505

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/30

1811AB AS1811AB P002496
40 00 00.0 085 45 00.0 4
PENDLETON
18 7.5 PENDLETON
T/GEIST RESERVOIR 051991
FALL CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/06/10	06 00								
CP(T)-			0.088	13.200	0.100	2.600	3.300	0.255	0.300
73/06/10	23 00								
73/07/20	08 00								
CP(T)-			0.250	16.000	0.180	2.260	3.800	0.201	0.208
73/07/20	20 00								
73/09/20	07 00								
CP(T)-			0.086	10.500	3.025	4.020	5.100	0.176	0.183
73/09/20	23 00								
73/11/01	07 00								
CP(T)-			0.190	22.000	4.400	3.360	5.100	0.167	0.172
73/11/01	22 00								
73/12/05	07 00								
CP(T)-			0.390	14.000	0.019	2.500	3.200	0.181	0.172
73/12/05	22 00								
74/01/04	07 00								
CP(T)-			0.700	12.500	0.040K	1.600	2.700	0.173	0.186
74/01/04	13 00								
74/02/05	07 00								
CP(T)-			0.160	12.000	0.920	2.700	5.500	0.203	0.310
74/02/05	22 00								
74/03/05	08 00								
CP(T)-			1.840	5.600	0.050K	1.050	1.050	0.610	0.287
74/03/05	23 00								
74/04/03	08 00								
CP(T)-			0.400	6.000	0.110	1.300	1.800	0.570	0.315
74/04/03	22 00								
74/05/08	08 00								
CP(T)-			0.080	18.000	3.100	2.000	4.300	0.183	0.283
74/05/08	23 00								
74/06/07	08 00								
CP(T)-			0.120	12.000	0.530	2.100	2.700	0.136	0.188
74/06/07	22 00								
74/07/11	11 00		0.040	9.300	0.560	0.710	1.350	0.170	0.275
74/08/02	14 00		0.240	19.000	14.000	3.200	4.400	0.122	0.151

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/30

1811AA AS1811AA P002300
39 59 00.0 085 46 00.0 4
PENDLETON STATE REFORMATORY
18 7.5 INGALLS
T/GEIST RESERVOIR 051992
FALL CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/06/05	08 00								
CP(T)-			0.820	3.000	0.350	1.680	2.000	0.300	0.250
73/06/05	20 00								
73/07/03	08 00								
CP(T)-			0.890	1.980	0.190	1.510	1.870	0.200	0.250
73/07/03	20 00								
63/11/08	17 00								
CP(T)-			5.900	2.300	0.120	2.700	3.500	0.500	0.420
73/10/09	05 00								
73/12/18	17 00								
CP(T)-			2.200	2.900	0.240	2.500	3.200	0.350	0.375
73/12/19	05 00								
74/01/30	06 00								
CP(T)-			2.320	2.000	0.210	3.200	4.700	0.330	0.450
74/01/30	18 00								
74/02/27	10 00								
CP(T)-			5.040	1.700	0.140	2.300	2.800	0.350	0.450
74/02/28	10 00								
74/07/24	09 00								
CP(T)-			4.300	1.000K	0.088	2.600	3.000	0.400	0.400
74/07/24	22 00								

K VALUE KNOWN TO BE
LESS THAN INDICATED